

MONTHLY WEATHER REVIEW.

Editor: Prof. CLEVELAND ABBE. Assistant Editor: FRANK OWEN STETSON.

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The MONTHLY WEATHER REVIEW is based on data from about 3500 land stations and many ocean reports from vessels taking the international simultaneous observation at Greenwich noon.

Special acknowledgment is made of the data furnished by the kindness of cooperative observers, and by Prof. R. F. Stupart, Director of the Meteorological Service of the Dominion of Canada; Señor Manuel E. Pastrana, Director of the Central Meteorological and Magnetic Observatory of Mexico; Camilo A. Gonzales, Director-General of Mexican Telegraphs; Capt I. S. Kimball, General Superintendent of the United States Life-Saving Service; Commandant Francisco S. Chaves, Director of the Meteorological Service of the Azores, Ponta Delgada, St. Michaels, Azores; W. N. Shaw, Esq., Secretary, Meteorological Office, London; H. H. Cousins, Chemist, in

charge of the Jamaica Weather Office; Señor Anastasio Alfaro, Director of the National Observatory, San José, Costa Rica; Rev. L. Gangoiti, Director of the Meteorological Observatory of Belen College, Havana, Cuba.

As far as practicable the time of the seventy-fifth meridian, which is exactly five hours behind Greenwich time, is used in the text of the MONTHLY WEATHER REVIEW.

Barometric pressures, both at land stations and on ocean vessels, whether station pressures or sea-level pressures, are reduced, or assumed to be reduced, to standard gravity, as well as corrected for all instrumental peculiarities, so that they express pressure in the standard international system of measures, namely, by the height of an equivalent column of mercury at 32° Fahrenheit, under the standard force, i. e., apparent gravity at sea level and latitude 45°.

SPECIAL ARTICLES, NOTES, AND EXTRACTS.

THE MOUNT ROSE WEATHER OBSERVATORY.

By Prof. J. E. CHURCH, jr., University of Nevada. Dated Reno, Nev., May 10, 1906.

It is through the kind invitation of the Editor that I venture as an amateur to present our endeavors and experiences in conducting high mountain observations on Mount Rose.

The project was born on Mount Whitney in March, 1905, during my attempt to scale that peak in winter, personally for the pleasure of the venture, but ostensibly to test Professor McAdie's theory of the possibility of establishing a station on the summit from which one could retreat at any season of the year, in case a prolonged stay at such an altitude should become dangerous to health. The sight of a forlorn thermometer box, abandoned during an early storm the preceding September, aroused my combativeness to the point of offering to maintain a station on Mount Rose for a year to determine the monthly minimum temperature on high Sierran peaks, which seemed so far to have guarded their secrets well.

Mount Rose, Nev., is south of Reno and north-northeast of Lake Tahoe, and, as already noted in the REVIEW,¹ forms the northern apex of the Carson Range of the Sierra Nevada; it has an altitude of 10,800 feet. More exactly, it is situated at latitude 39° 20' north and longitude 119° 55' west. Its value as a site for a mountain weather observatory lies in the fact that the mountain is so surrounded by the great depressions of the Lake Tahoe and Truckee River basins that its summit furnishes an ideal site for observing the condition of the weather in mid-air.² It also rises in the agricultural zone on the height of land between the California basin and the Nevada-Utah plateau, so that an observatory here would be of service in furnishing data as to the constant air movements from the Pacific coast and in reporting approaching weather conditions to the districts farther east. Particularly was its selection due to its nearness to Reno and faith in its approachableness throughout the winter.

The standard maximum and minimum thermometers and rain gage were soon furnished, but I was instructed to provide my own shelter after plans furnished by the Weather

Bureau. To do this was obviously impossible, both on account of the size and expense of the standard shelter and the strong possibility of its filling with snow. The problem with its opportunity was presented to the Nevada Academy of Sciences. After much consultation, a small shelter was evolved, light and airy, yet compact and suited to stand any gale known to blow on the mountain.³ The bottom was made of slats to permit the incoming snow to depart without gaining lodgment within. The cost of the woodwork and the setting up at the planing mill was \$6; the paint and iron fixtures were extra. The instruments were securely fastened to cast-iron brackets

¹This thermometer shelter is made especially heavy in order to diminish the influence of its own oscillations, as tending to make the index of the minimum thermometer slide downward or upward to a reading other than that corresponding to the actual temperature. The construction is shown in fig. 4, and accords with the following specifications:

The shelter consists of two upright pieces of timber, 2 by 4 inches by 6 feet, for the front, and two pieces 2 by 4 inches by 5 feet 9 inches for the rear supports. These uprights are mortised into 4 by 4-inch horizontal supports, resting on the ground, and are braced with iron straps. The 4 by 4-inch pieces are held together by two 1-inch boards, about 12 inches wide. The construction is shown in the diagram. At the front and rear of the upper end of the upright supports are screwed two pieces, respectively, 1 inch by 5 by 24 inches and 1 inch by 2½ by 24 inches. The roof is made of 1 inch matched lumber, and is 26 inches wide by 28 inches long. The fastenings are screws. Underneath the roof supports is screwed one ceiling piece, 1 inch by 24 by 24 inches. The front and rear sides of the shelter are a framework consisting of seven louvers ½-inch by 4 by 19 inches, slanting at an angle of 60° and mortised into pieces 1 inch by 2 by 25 inches as shown in fig. 4. The rear side is screwed fast between the uprights. The front side is pivoted at the lower end of the frame on two ½-inch by 4-inch carriage bolts, forming the door for access to the instruments. When closed the door is held in place by a hasp and staples, as shown in fig. 4. The other two sides are of similar construction, but have louvers 15 inches long and both frames screwed between the uprights. The bottom consists of a framework of two pieces 1 inch by 4 by 20 inches, screwed across the front and rear uprights. Into these are mortised 13 slats, ½ inch by 2 inches, set to a depth of 1 inch and spaced 1 inch apart. The ends are cut to a 60° angle in order to fit snugly under the bottom louvers. Two pieces, 1 inch by 2 by 24 inches are screwed across the front and rear uprights, 8 inches below the bottom of the shelter. Upon this support is screwed a ½-inch board, 24 inches square. The whole structure is given three coats of white lead (except the upper surface of the shelf, which should be painted black), and so put together that by unscrewing the top, bottom, shelf below the bottom, the louver frames, and the cross supports at the base, the whole may be easily put upon pack animals (as shown in fig. 3), and transported to the mountain top, where it is designed for use.

¹ October, 1905, Vol. XXXIII, pp. 444-445.

² Figs. 1 and 2 show the horizon as seen from the summit of the peak, looking westward and southward, respectively. To the west we look over the valley of the Truckee River, with Donner Lake in the distance; to the south we get a partial view of Lake Tahoe.—C. A.



FIG. 1.—View from the summit of Mount Rose, looking westward.



FIG. 2.—View from the summit of Mount Rose, looking southward.



FIG. 3.—Transporting the shelter to the summit—the thirteenth fall.

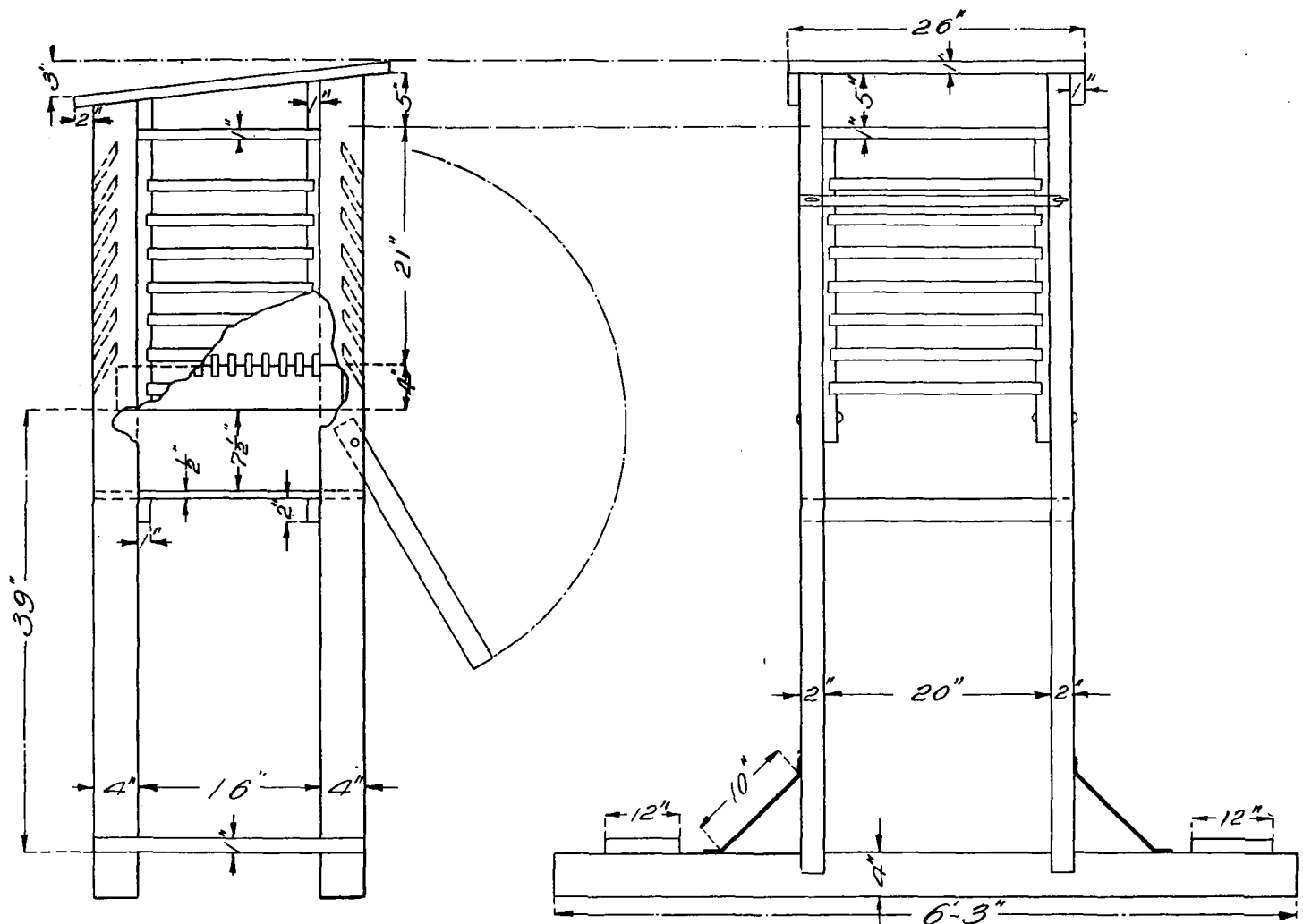


FIG. 4.—Construction plan of instrument shelter for use on Mount Rose. (Slightly reduced from the working drawings.)

projecting from the ceiling of the shelter. This would require dismounting the instruments in order to reset them, but would at the same time keep them out of reach of any probable banking of the snow on the floor of the shelter.

How to get the shelter into position on the summit was the next problem before us. In the early season a sled and a company of enthusiastic students or members of the academy to draw it had seemed the readiest means, but some had already had their waist lines deeply cut by sled ropes on a similar venture. It was then determined to have recourse to horses when the snow should disappear on the lower levels and the snow fields about the summit should become sufficiently compact to bear their weight. Finally, on June 28, 1905, the shelter was comfortably settled on the bed of a spring wagon and drawn over rough upland roads to the head of vehicle travel, at the meadow in Jones Canyon. Here the screws were quickly removed and a huge sawbuck formed of the main timbers of the shelter upon which were bound the louvers and other square pieces, the rain gage resting in the upper part of the sawbuck.

At dawn of the 29th the load was lifted to the back of a saddle pony, and the party started slowly for the summit. A riding saddle, firmly cinched, prevented the sawbuck from sliding backward over the pony's tail, while the low center of gravity prevented the load from rolling, even when no additional cinch rope was employed. An abundance of bed quilts between the riding saddle and the load prevented any chafing. (See fig. 3.) Without ill accident, except one unpleasant fall

in a clay ravine, the pack pony arrived toward noon at timber line, but here the snow fields almost brought disaster. The wind pits were so deep and the snow so rotted by the sun that when the pony was not stumbling among the pits he was floundering in the rotten snow. After the thirteenth fall, the last snow field was surmounted, but the pony had become utterly exhausted and the sun was low. There yet remained the mountain top of loose slate-like rocks. Professor Doten, the weather man of the party and coorganizer of the plan, wisely counseled retreat until later in the season. However, a second horse, less sure of foot, was substituted, and succeeded in bringing the outfit to the summit. Three pairs⁴ of willing hands soon mended the battered louvers and assembled the parts of the shelter. One woman of the two who started was present to grace the occasion; Mrs. Church was tarrying on the rock pile below to warm and comfort the only child in the party, whose feet had become cold and wet on the snow fields farther down.

The setting sun was dipping behind the summit range of the Sierra when the little white shelter, another "lighthouse" in the western skies for meteorology, stood forth full-formed on its knife edge of rock,⁵ ready to record the freezing tem-

⁴ The writer's brother, Mr. John E. Church, of Michigan, and his wife shared in the undertaking.

⁵ Fig. 5 gives a view of the summit and the thermometer shelter, and the rocks piled up to shelter the observer, and also used as a signal in geodetic triangulations. This view was taken shortly after the storm of November 19-29, 1905.—C. A.



FIG. 5.—The shelter on the summit of Mount Rose.

perature gathering about us. With long, loud “yodels” in celebration of the event, we plunged into the night and emerged the next dawn at the headquarters ranch at the base of the mountain.

Since that time a trail has almost been worn on the mountain; at least, the number of ascents has vanished into the realms of uncertainty. But the experiences have been so novel that interest in the venture has steadily increased. Sometimes the reporters have pictured distressing perils besetting the climbers, and created a halo of glory about their heads.

TABLE 1.—*Minimum and maximum temperatures.*

Period.	Minimum.	Maximum.
	° F.	° F.
June 29–August 4, 1905.....	+24	71.2
August 4–September 4, 1905.....	— 2	70.8
September 4–October 7, 1905.....	— 4.5	65.5
October 14–October 30, 1905.....	+ 7	46
October 30–December 3, 1905.....	— 1.8	52
December 3–January 30, 1905–6....	— 5	48
January 30–March 4, 1906.....	+ 9	36
March 4–March 18, 1906.....	+ 3	44
March 18–April 7, 1906.....	— 2.5	30
April 7–May 5, 1906.....	+11	44.3
May 5–May 31, 1906.....	+ 7	49.5
May 31–June 16, 1906.....	+10	45
June 16–June 25, 1906.....	+30	58
June 25–July 14, 1906.....	+22	71

The preceding table represents the minimum and maximum temperature readings, arranged approximately by months, from the erection of the shelter to the present time.

The first three sets of readings were obtained from the maximum and minimum thermometers alone. The first low reading, -2° F., was so startling that I immediately began to search for some defect in the instrument or the shelter. The shelter had not yet been firmly anchored, and was capable of considerable vibration in a gale of wind; but the minimum instrument, according to a crude water-level hastily formed from a piece of board, was so tilted that any vibration would tend to shake the needle up instead of down, as has been done on several occasions since that time. The second low reading, -4.5° F., is authenticated by a -1° F. at Bodie, Cal. (altitude about 8500 feet), on September 30. Since Bodie resembles Mount Rose in being situated among the outlying eastern spurs of the Sierra Nevada, but lies 100 miles to the south, the theory of widely-extended descending currents of air immediately suggests itself, to which cause the first low reading appears largely traceable. At least, the temperature at about that time varied greatly on the mountain from night to night, according to the report of Prof. P. B. Kennedy and Mr. Dinsmore, who were encamped at timber line making a botanical survey of the summit; during one night a single blanket was

quite sufficient for comfort, but the next all the bedding in camp would not suffice.

But the meagerness of the data was tantalizing. When and how rapidly did the fall in temperature occur? Did it attend the severe thunderstorm of August? What was the average temperature of the summit? In a word, what information would continuous records afford us? Our speculations were brought to results when, on October 7, my fingers were so badly frost-bitten that I could not handle the instruments and was compelled to beat a precipitate retreat. The thumb-screws of the supports which I was compelled to remove each time in order to reset the thermometers had so frosted my fingers that they had become wholly devoid of control, although the actual temperature was only 23° F. Edward Whymper, in his "Travels amongst the Great Andes of the Equator," relates a similar experience with the vernier screws on his mercurial barometer.

The new Townsend mounting⁶ was then installed, with the intention of placing the instruments in the exact center of the small shelter where they could be readily revolved with a gloved hand. A Richard barograph and a Richard thermograph, reading down to -30° F., were borrowed, through the cooperation of Professor Doten, from the State University, and duly installed on October 14 to check any discrepancy in the thermometers and to supplement the records. From their installation dates the real value of the observatory.

⁶ Devised for maximum and minimum thermometers by T. F. Townsend, section director, U. S. Weather Bureau.

By the assistance of Prof. G. D. Louderback, our physicist, and Prof. J. R. Johnson and Mr. Prather, all of the University of Nevada, continuous records were obtained by weekly visits from October 14 to November 29, 1905. During December and January the observatory was visited twice, and sleeping-bags and provisions were hung in a tree at Contact Pass, near timber-line, for refuge in case of need. Since January 21, 1906, a biweekly service has been maintained in all weathers, the instruments furnishing a continuous record for ten days of each two weeks and a maximum and minimum reading for the remainder of the time.

The data so far obtained have been various, and indicate the need of further investigation rather than the attainment of final results.

The most noticeable characteristic of the temperature on the summit is the smallness of the mean daily range as compared with that of the valley below. During the six weeks of continuous records the mean daily range was only 13.8° F., while that at Reno for the corresponding period was 31.3° F. During December 3-11, the mean range was 9.4° F., during January 22-30, 7.8° F., and February 5-12 and 19-23, 8.7° F., while the corresponding mean ranges at Reno were 27°, 21.6°, and 23.4° F., respectively. During the months of March and April the relation remained approximately the same, the mean daily range on Mount Rose during March 5-12 and 19-27 being 9.8° F., and during April 8-16 and 24-30, 10.2° F., as against 25.6° and 24.9°, respectively, at Reno. The difference is more strikingly shown, however, by a comparison of the record sheets. (See figs. 6 and 7.)

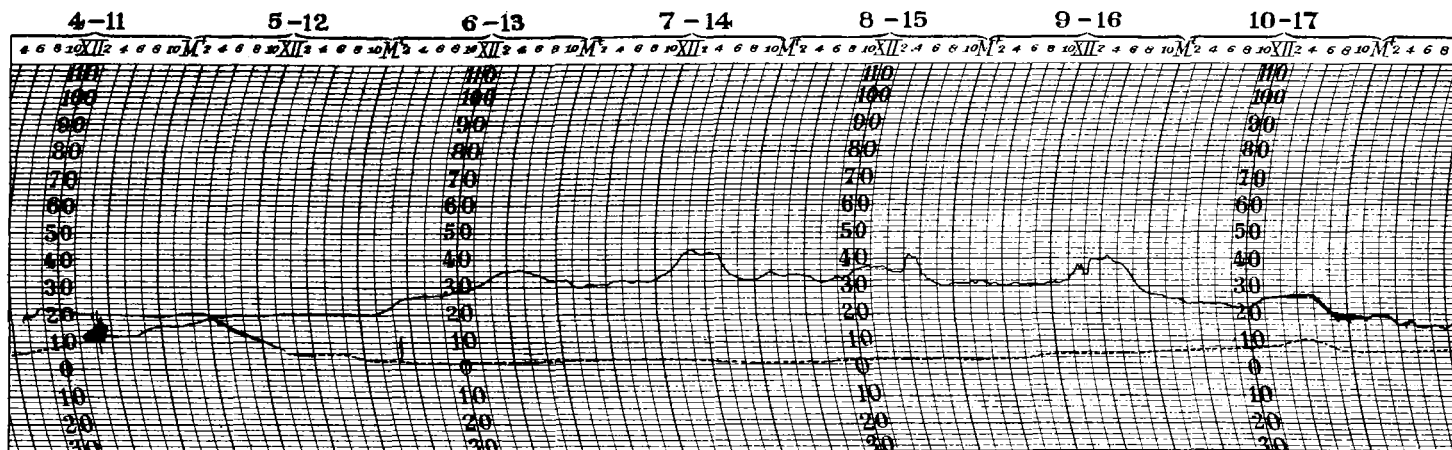


FIG. 6.—Thermogram, summit of Mount Rose, March 4-18, 1906. (As the sheet was not changed at the end of one week, the record for March 11-13 overlaps that of March 4-6. The continuation of the record, after the clock ran down, at 4:30 a. m. of the 13th, is given in dotted lines. The time scale is that of the 75th meridian.)

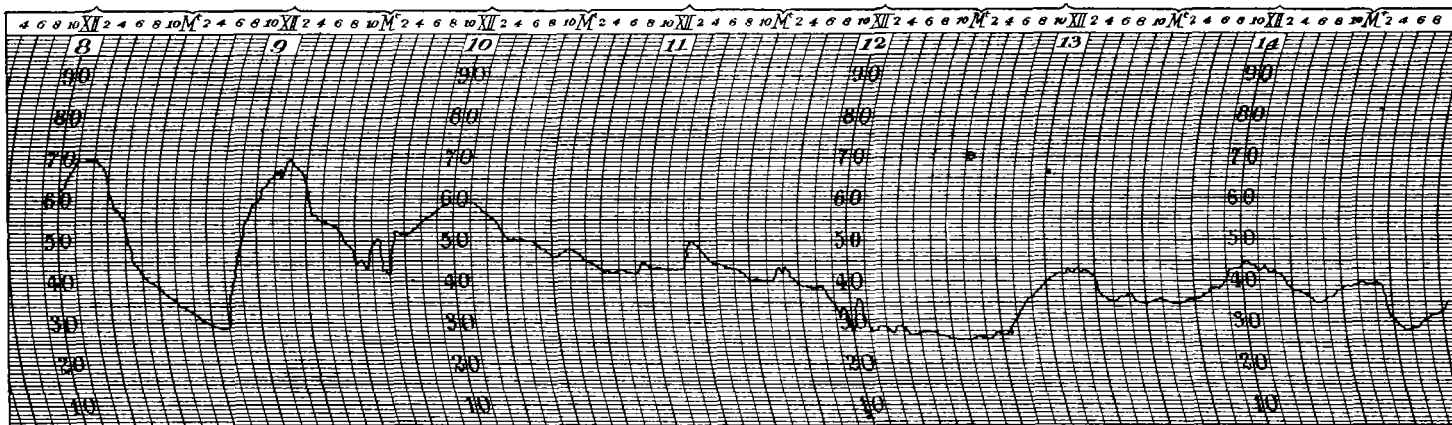


FIG. 7.—Thermogram, Reno, Nev., March 8-15, 1906. (Personal readings of the standard thermometer were made several times daily, and gave corrections to this thermogram ranging between -2° and +3°, which are shown on the original sheet, but omitted on this copy. The time scale is that of the 120th meridian.)

The next characteristic is the constant low temperature that prevails on the mountain. During the six weeks in October and November referred to, the mean minimum temperature was 20.4° F.; on three days only was the minimum temperature above freezing, while on sixteen days the minimum temperature was below 20° F., on eight days below 10° F., on five days below 5° F., and two days at zero or lower. The lowest recorded temperature was -1.8° F.

During January 21–30 the mean minimum temperature was 18.4° F. and during February 4–13, 17.1° F. Although during the above eighteen days the thermometer did not fall below 10° F., neither did the maximum reading rise above freezing, except upon three days, February 5–7.

During the unregistered period from December 12 to January 21 the thermograph indicated at least one reading of -2° F. and one of -5° F.

On April 1 the temperature fell to -2.5° F., and out of twenty-three days of this month rose above freezing on only four days. During the remaining seven days, of which only the maximum and minimum temperatures were available, the temperature fluctuated between 18° and 44° F.

The winter temperatures recorded seem strangely high when compared with the temperature of -39° F., once recorded at Summit, and that of -25° F., reported at Truckee a year ago, or with the temperature of -50° F., once recorded on Mount Washington. But the season has been comparatively mild and the snowfall unusually heavy.

The evenness of the temperature at this altitude, or rather the tendency of the temperature to fall to the zero level at intervals during so large a part of the year, may indicate a nearness of cold air masses in the higher levels not yet fully understood.

Another manifestation of Mount Rose, due to the isolation of its summit from other land masses, is the fluctuation of the temperature during the middle of the day. This is due to the uneven warming of the air-cap on the summit and of the air floating in the abyss around it, so that a warmed mass of air is being forced upward from the summit at very brief intervals, like some huge balloon, by the colder air which presses inward from all sides to take its place. These fluctuations of from 4° to 6° F. are often appreciable to those endowed with a keen sense of temperature, while on the thermograph record sheet they appear like tiny jagged pinnacles.

The barometric indications have been no less interesting than the themometric. The pen of the barograph on the summit of Mount Rose is much steadier than that at Reno, 6268 feet below, and the curvature of change is much longer. Also the general fluctuation of the pressure on the mountain appears to be 0.10 to 0.15 inch less than in the valley below. From December 13 to January 21, however, and also from March 8–17, this condition was reversed, the greatest range on Mount Rose during the earlier period being 1.25 inches as against 1.10 inches at Reno, and during the later period 1.30 inches on Mount Rose, as against 1.05 inches at Reno. (See figs. 8 and 9.)

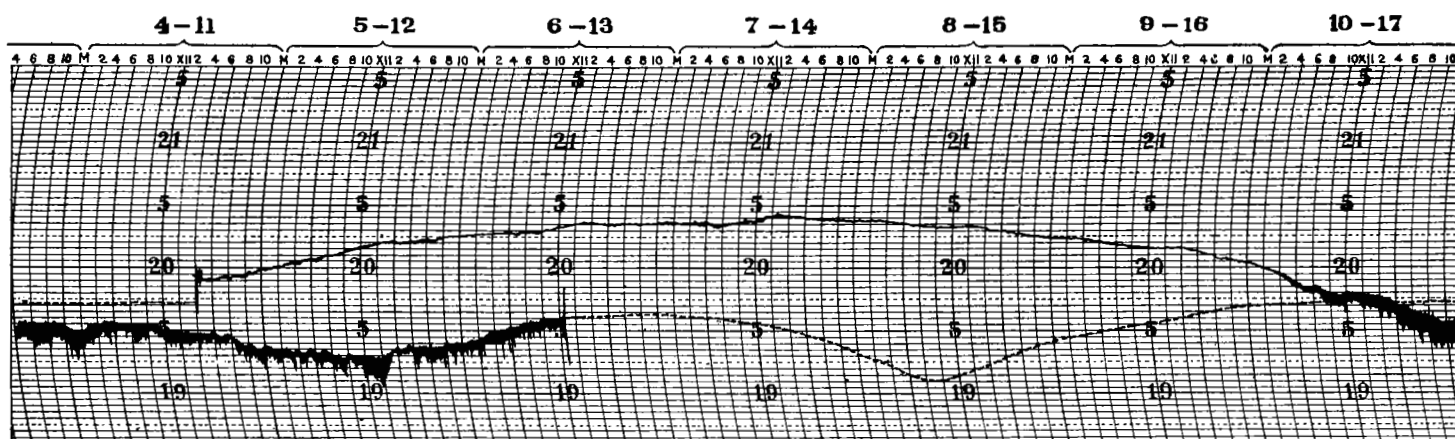


FIG. 8.—Barogram, summit of Mount Rose, March 4–18, 1906. (As the sheet was not changed at the end of one week, the record for March 11–13 overlaps that of March 4–6. The continuation of the record, after the clock ran down, at 12:30 p. m. of the 13th, is given in dotted lines. The time scale is that of the 75th meridian.)

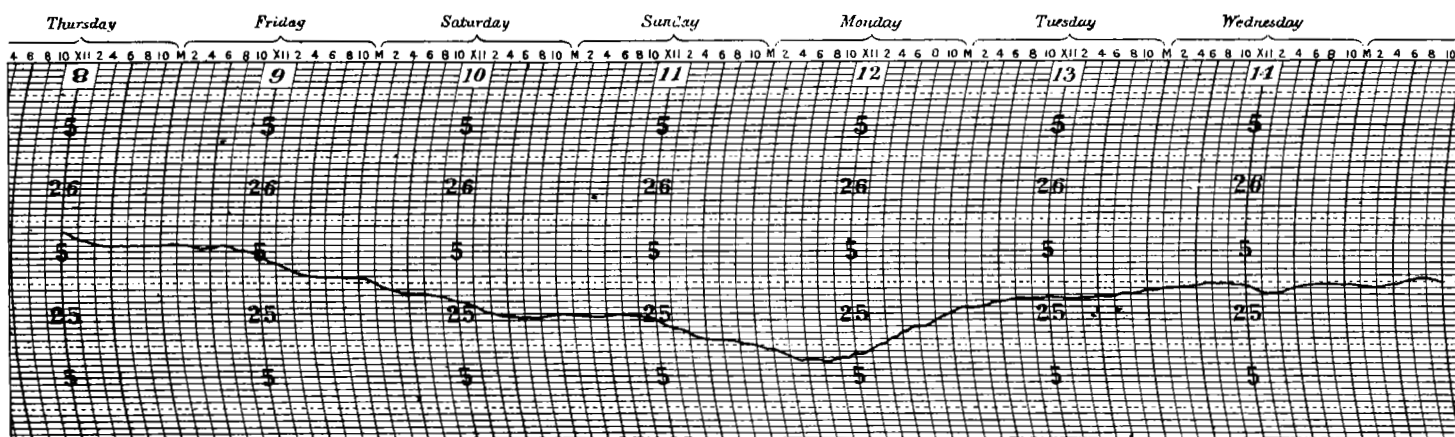


FIG. 9.—Barogram, Reno, Nev., March 8–15, 1906. (Readings of the standard barometer were made twice daily, and gave corrections to this barogram ranging between $+0.01$ and -0.01 inch, which are shown on the original sheet, but omitted on this copy. The time scale is that of the 120th meridian.)

The correspondence between the fall in temperature and the fall in pressure is everywhere evident from the record sheets. Only once is the rising curve of barometric elevation accompanied by a falling curve of temperature; this occurred November 23-25, 1905, during a heavy snowfall on the summit which is clearly shown by the spreading of the ink from moisture; however, the curve of change shown by both instruments was slight. Furthermore, the lowest temperatures so far observed attended storms. The temperature of 10° F. at noonday, November 5, accompanied a falling barometer and a hysterical condition of the atmosphere; a 40-mile gale was blowing. The temperatures of 4° and 0° F. recorded November 20 and 21 also accompanied a similar pressure condition, when a general storm swept the great plateau; and the 0° F. of November 25 and December 3 accompanied another period of depression. Finally the 10° F. at noonday on February 22 and 23 and March 4, the 7° F. at noon of March 18, and the -2.5° F. at 10 a. m. on April 1 occurred during periods of storm.

The most striking characteristic of the barograph record, however, is the evidence of swirls during a falling or variable pressure. This is shown by the pumping of the instrument, which is so sharp and sudden that the observer at first thinks only of ghosts and then of impending tempest. This condition is due probably not to the partial vacua caused by violent winds beating against the summit, but to the unevenness of pressure caused by swirling movements at high elevations; at least pumping of this character seems to be entirely wanting in the records from the lower level at Reno. The theory of swirls is supported by the fact that pumping of the barograph is sometimes accompanied by corresponding vibration of the pen of the thermograph, due to the varying temperature of the turbulent masses of air. The rising air-cap already referred to will not account for the action of the thermograph, since the action occurs during storms when the rays of the sun are excluded by clouds and the wind is high.

Strong evidence corroborating this theory was obtained during the trip to the summit on March 18, 1906, after the extraordinary storms of March 9-17, when evidences of swirls were visible in the whirlwinds still passing over the shoulder of the mountain and across the amphitheater at the northern base of the summit. Many of these were tiny. A few, however, were large, one being at least 500 feet high and many rods in diameter, as was shown by the cloud of snow sucked up by its current. High above the mountain sailed cloud plumes (or tubes) standing on end, through which some disintegrating process was swiftly making its way upward, until the plume vanished. When the shelter was opened the barometric record was found to be a continuous band, caused by the constant pumping of the barograph during that portion of the storm recorded by the instrument, conclusively showing, it would seem, that the swirl then seen about the summit was the remnant of the prolonged period of violent swirl accompanying the recent storm.

The relation of the weather on Mount Rose to that at Reno and San Francisco can be determined even approximately only after a long series of comparisons of continuous records. One or two incidental observations, however, will indicate the value of such comparisons. During the period of February 4-13, 1906, an even high pressure at San Francisco was accompanied by an exactly similar condition on Mount Rose, showing that the tranquility of the atmosphere extended to a considerable height, and hence gave promise of some permanency. Again, on November 5, 1905, a gale on the ocean front of California was accompanied by low temperature and a fierce blizzard on the summit of the Sierra Nevada, while the atmosphere of the Sacramento Valley remained clear and sultry. And on November 19, 1905, a gale of 40 miles, which was the precursor of the general storm, was met by the observer when

on the mountain top at 2 o'clock, six hours in advance of its arrival at Reno by way of the Truckee River basin.

The most important result of this first winter's experiments, however, is the perfecting of a shelter that has kept itself free of snow during the heaviest snowfall that has occurred for ten years. The only additional safeguard used was a piece of coarse flour sacking tacked over the louvers on the side most fiercely beaten by the wind. On account of the fear that intense nocturnal radiation might be the partial cause of the low readings during the autumn, a hanging bottom was placed a few inches below the louvers, where the wind could sweep it clear of snow. To prevent the sun from striking this bottom and being reflected upward to the instruments a heavy curtain has been designed to close the aperture on the sunny side, but to be so hung that it can be forced backward by the wind and thus permit the blowing away of the accumulating snow. There is a question, however, regarding the necessity of a closed bottom, for the records obtained since the addition of this bottom vary in no appreciable degree from those taken before.

The encountering of storms during various ascents and the traversing of snow fields throughout the winter have yielded much detailed information regarding the action of storms and the storage of snow on the slopes of the mountain, which may be of interest to the Bureau of Forestry. Some photographs have already been made, and many more are planned as soon as Professor Kennedy can resume field work.

The study of storm action has been fascinating. The great bulk of the mountain forms a dike, around which the wind acts much as the tide boils and seethes around a reef—only the action of the atmosphere is titanic and terrifying. In the storm of November 19, 1905, the clouds seemed to be catapulted against the mountain with terrific force until they struck the air cushion a few feet from the mountain face, when they sped upward on the current that was rising over the crest. This violent eastward movement caused a contrary wind to the leeward of the summit so strong that my body became almost buoyant as I plunged down the mountain against it. On the summit itself the shriek of the gale and the vibration of the shelter were sufficient evidences of the wild turmoil, without the further indication furnished by the sharp pumping of the barograph. The strong stoppage of the air movement by the mountain for some distance from its base was shown by the rise of the yellow smoke from a wild fire on the upland until it reached the altitude of the summit, when it abruptly joined the mad flight of the clouds. I hastened down the mountain, and when, at the mouth of Jones Canyon, I gazed behind me, I was astonished to find the mountain completely white with snow. By the aid of a cloud burst autumn had been changed into winter at my heels.

Although the velocity of the wind at this time was equalled on several other occasions, only once is it known to have been exceeded, when an estimated velocity of 80 miles blew on the summit. This occurred during the series of storms that raged throughout Nevada from January 9 to 19. On January 14 the wind blew so violently that the people on the headquarters ranch were sleepless all night through fear that the house would be blown over. One outhouse was leveled, and on the following Thursday a wind somewhat more severe stood the outhouse on end against another building. Mr. Vogel, who vividly recalled the previous storm when the sage-brush fire burst from his control, declared that this wind was four times as bad. For more than a day no attempt was made to feed the stock at the stack on account of the impossibility of preventing the hay from being scattered over the ranch. The snow, which at this time was waist deep and threatened to crush in the roofs of the buildings, was so wet by the sleet that followed and so firmly frozen that two days later, on the January trip up the mountain, I rode to the ranch upon its surface.

Besides the problems already enumerated, two other prob-

lems will receive special attention. Professor Kennedy, who discovered ten new species of plants around the crest of Mount Rose, will conduct a series of observations on the hardiness of these plants, one of which was found with fruit unspoiled after the zero temperature of August or early September.

The study of the influence of the unbroken chain of the Sierra Nevada upon storm movements and cloud formations will be undertaken by Professor Louderback. The opportunity afforded at Reno is probably one of the best in any of the more accessible portions of the world.

Arrangements will also be made, if possible, to conduct a series of experiments on Mount Rose to determine the rate of evaporation there.

The pressing needs of the present service on Mount Rose are instruments that will run at least one month and a cabin on the summit for protection while changing the record sheets. When it is considered that each trip involves a ride of 36 miles and a tramp up and down the mountain of 8 miles, or in winter a ride of 32 miles and a tramp of 12 miles, which consumes in summer at least 15 hours and in winter from 2 to 2½ days, it will be realized that continuous records can not be obtained with the present 10-day instruments without requiring an exertion far beyond the power of the present force of observers, who are carrying a full burden of work at the university in addition to the present undertaking. The biweekly winter service is a heavy draft on the flesh and the spirit of the two who have been keeping it up. Additional recruits, won by Professor McAdie's recent lecture on mountain observatories before the university, have made possible the formation of two parties instead of one. But the break in the records of at least four days every two weeks, with the strong probability that storms may occur when the instruments are not running, impairs the value of the work. One of the most regrettable losses of the entire year was that of the record of the storm of January 9, the worst of the season, at a time when the self-registers had run down. What the record might have been is shown by the extremes that were registered on the stationary sheets and by the accompanying facsimiles¹ of the barogram and thermogram during the late extraordinary storm of March 9-17. (See figs. 6 and 8.)

Moreover, with instruments that run longer, the observers will not be compelled to take the risk of freezing or becoming lost in dense fogs such as occurred on April 1 and 3, when two unsuccessful attempts were made to reset the instruments, which were securely guarded by intense cold and impenetrable fog, after the stopping of the clocks had made an early change of the record sheets imperative. The third attempt, made only one week after the first failure, was wholly successful, owing to the passing of the storm and the rise of the temperature.

The cabin now promises to be within our reach. Mr. Singleton Charnock, a student of the university and formerly a ship's carpenter, has accompanied Professor Johnson to the summit, preparatory to making plans for a well-arranged cabin which he has undertaken to construct. The merchants of Reno will be asked to donate the material. The value of this cabin will be inestimable. In the first place, it will make possible the comfortable and perfect adjustment of the record sheets, and prevent such spoiling of the sheets and washing of the ink from the pens as occurred in the blizzard of February 18. It should also put an end to the almost constant frosting of finger tips. In the second place, it will supersede the sleeping-bag resort at the timber-line, which has been utilized during the winter and spring on account of the condition of the snow and the weather. But, more important still, it will provide an outlook from which storms can be studied from their beginning to their end, with perfect comfort to the observer. The only

risk—that of lightning—can be avoided, it is thought, by placing the cabin a sufficient distance from the apex of the mountain, where the thunderbolt is wont to strike.

Barograph and thermograph instruments perfectly adapted to our needs can be obtained for \$200. It is believed that the ink will serve nearly every demand put upon it, but if not, the plan of tracing upon smoked paper, suggested by Professor Marvin, can be tried. A standard anemometer has already been loaned by the university and a single register by the local office of the Weather Bureau. The latter will be used until a long-time instrument can be procured. Can not the Weather Bureau obtain the necessary barograph and thermograph instruments?² The investment would be trivial compared with the possibility of obtaining valuable results. Furthermore, the establishment of one mountain observatory of the volunteer type may lead to the establishment of more at pivotal points, at least during the summer months, until this pioneer stage can be followed by one or more elaborate mountain stations with kite and balloon equipment. Then the great sentinels of the Pacific coast will become the most valuable outposts of the weather service.

NOTE.—Specific acknowledgment should be made to Professor Doten and Miss Katherine Lewers, university photographers, and to Prof. J. G. Scrugham and Mr. J. A. Nadon, of the School of Mechanical Engineering, for the preparation of the illustrations, also to Mr. N. H. Jensen, assistant observer, Reno, Nev., for typewriting the text of this article, and to Prof. A. G. McAdie, San Francisco, Cal., for suggestions and encouragement since the inception of the work. The writer is also under obligation to Capt. R. M. Brambila, Mr. George D. Powers, Dr. J. F. Rudolph, Mr. Howard C. Barker, and Mr. Philip S. Cowgill for sharing in the more recent ascents, and to Mrs. Pauline Streckenbach, proprietress of the headquarters ranch near Mount Rose, whose unfailing generosity and interest in the cause have made possible the winter ascents of the mountain.

ADDITIONAL NOTES ON MOUNT ROSE, NEV.

In a letter of June 7, from Reno, Nev., Prof. J. E. Church, jr., calls attention to the possibility of using the records on the summit of Mount Rose (altitude 10,800 feet) for predicting the occurrence of frosts over the adjacent lowlands, especially the Truckee meadows and the Carson sink, which it is proposed to reclaim by means of irrigation. According to the thermograph record a period of low temperature began on the mountain top at noon on Monday, May 14, thirty-six hours before the first appearance of frost, late Tuesday night, on the floor of the adjacent valley. The thermometer on the summit continued to fall during Tuesday and Wednesday; the figures were 12° above zero on Monday, and 7° above zero Wednesday morning, with a corresponding fall in the barometer. Frost first appeared in the valley below Wednesday morning, and continued to Thursday morning. As the area covered by this frost moved eastward over the State it should have been possible to predict it two days in advance by the records from the summit of Mount Rose. It preceded the formation of an area of high pressure that advanced eastward and became central in Idaho on the morning of Thursday, May 17, and it was evidently a typical illustration of air cooling by radiation and settling down under a clear sky while fresh air flowed in above it.

An analogous study of comparative weather conditions, especially temperature, has been made by Professor Barnes at Montreal, Canada. A telethermograph of special construction gives him simultaneous temperatures at the summit and base of Mount Royal, and cold at the base is almost always preceded by low records at the summit. When we have learned why this connection is not invariable we shall probably be able to use mountain records in forecasting the frosts of the lowlands.

² The Government includes both Congress and the Executive. The Weather Bureau can only carry out the laws of Congress and the orders of the President. It can not spend money for the observatory on Mount Rose without specific authority from Congress.—C. A.

¹ The dotted lines represent what would have been approximately the tracings by the instruments had they run throughout the storm.

Every new mountain observatory is a new field of aerial exploration greatly needed and most welcome to the true meteorologist.—C. A.

The interest in the frost studies has been heightened by a second observation like the one already mentioned, i. e., that low temperatures on Mount Rose seem to precede those below at Reno and in the northern section of Nevada by from twenty-four to thirty-six hours. Thus on the morning of June 6 (2 to 5 a. m.) the thermograph on the summit registered 11° F. The temperature during the day registered from 23° to 20° F., rising from 10 p. m. until about 6 a. m. of the 7th, when it registered 37° F. On the morning of the 7th, at Reno, however, a killing frost was reported, twenty-four hours after the corresponding condition on Mount Rose had occurred and at the same time as the rise of temperature from 20° to 37° F. was taking place on that peak. If there had been a simultaneous correspondence on Mount Rose and at Reno, the frost at Reno should have occurred on the morning of the 6th and a temperature of approximately 57° F. should have been recorded at that place on the morning of the 7th.

The Nevada Agricultural Experiment Station has now, with the consent of the Division of Experiment Stations, made an appropriation for the purpose of continuing these frost studies and investigations in precipitation and evaporation at high altitudes. This will enable us to obtain an anemometer, a barograph, and a thermograph capable of making a month's continuous record, and a small observatory ten feet square for housing instruments and sheltering observers. A large precipitation tank and small evaporation tubs will be installed. The standard thermograph and barograph now in use may be placed elsewhere, either on Mount Rose or on a neighboring peak, to continue the study of barometric and thermometric peculiarities mentioned in my article; they may also be used in the further study of plant environment on Mount Rose.

It is interesting to note that the mean daily range of temperature on Mount Rose has not increased to a remarkable degree, the extremes during June being 5° and 23°, and that the approximate difference in temperature of 20° between Reno and Mount Rose has been increased often to 30° or more.⁹ A more careful comparison of both winter and summer readings at the two stations will be made as opportunity is afforded.—J. E. C., jr., July 26, 1906.

USE OF THE LANTERN IN TEACHING METEOROLOGY.

By J. PAUL GOODE, Assistant Professor of Geography, University of Chicago. Dated Chicago, Ill., July 1, 1906.

With many well meaning people the magic lantern is in something of disrepute. One says, "When I see a lecturer beginning to set up his screen and lantern, I know that now there is to be put on exhibition a plentiful lack of wit". And another says,¹ "The instruction in meteorology * * * needs to be of a fundamental, solid character, and not of the popular, superficial character appropriate to lectures that are illustrated by lantern slides"; and again, "A lecture with stereopticon illustrations should come in only as a sort of luxury once or twice during the course".

This attitude of antipathy is catching, like measles, and in many places settles the question of the use of the lantern without argument or evidence, adversely to the judgment and interests of the growing scientific teacher. Of course we all know the brainless person, who calls for "the next slide"; and announces the very obvious fact: "This is the picture of a house"—going through with a so-called "lecture" by talking about a collection of slides. Such performances may be entertaining, but they are often neither scientific nor literary, and may have little or no power of instruction. But to pass judgment on the use of the lantern upon such a basis of

evidence is on a par with the action of the good people who condemn all novels because there are, forsooth, dime novels. We can all understand this impatience with the merely entertaining use of the lantern, but that is only one side of the shield. Let us look at the other side.

We will all agree that, from any point of view, the most fundamental element of geography is the matter of space relation. In its ultimate phase, geography is the science of the "where", and the written language of the "where" is the map and diagram. Now we can not *talk* a map. We see a map, and we think it in terms of space relation, in terms of form and place, but we can only talk *about* these things. The sight language is many times more rapid and efficient than the verbal description of the visible forms. It is a sort of shorthand of form and space relation. Think of how long a chapter it would make to describe a map of the North American Continent, in its three dimensions, with its mountain axes, and with its intricate detail of coast line and drainage. And yet this mass of detail is presented to the eye in an instant. One second of view brings to us a quantity of perceptions it would take many minutes to relate even in part. In short the sight language, compared with the word language, is as the flight of an eagle, compared with the painful passage of an ox team. Moreover, we can keep the map in mind easily, while the very number of things listed in words becomes difficult of retention in memory, and very hard to correlate. We all understand this. We want the map when we really want to know the lay of the land, and no amount of explanation will take its place. So we provide our libraries with atlases and our geographies with maps, and even the clerk of the rural school sees to it that the schoolroom is supplied with some kind of wall maps. Our best schools have more wall maps and better ones, yet scarcely one has so many or such good ones as could be most profitably used in class work by a live and well trained teacher.

But wall maps are expensive. They run from three or four dollars apiece to several times that price, and the mere cost of a large collection becomes burdensome to the best of schools. They are bulky, and their storage is a problem, and the larger the number the harder this problem. Then, too, they deteriorate rapidly, even under the best of use. All these handicaps are so effective that the result is a very small and inadequate collection of wall maps in the average class room.

But the teacher in geography and meteorology must use maps. And we who are teaching know too well the waste of time and attention, and the cancellation of good teaching, when we attempt to do the next thing, that is, to bring into the class the good map or intricate diagram which we may have found in the MONTHLY WEATHER REVIEW, and which shows exactly what we want to present. We put up the beautiful little drawing before the class and the two pupils in the front row, nearest the map, get a good view and can follow the discussion. Those a little farther away can see a little, but uncomfortably. If the class is of ordinary size the others can not see, and in so far can not attend the recitation; they do not know what is going on up in front, and disorder enters the room. In a well trained school they may look wise and make no disorder, but they are barred from participation in the recitation. But then, of course, the map can be passed around, yet this is only less bad than the other way. The discussion was for the benefit of the two who could see the map. The teacher has now passed on to another topic. The map comes to a pupil who may now see what he was hearing about some time before, but in seeing he must lose the recitation just now in progress. And the attention and concentration of the whole class for a good fraction of the recitation is sacrificed to the lack of proper equipment—the want of a map that all may see at once and at the time when the seeing should be done. And is it not a pity that this high tariff should be imposed upon teaching, when by the expenditure of fifty cents that map may

⁹ The latest records have been added to Table 1, page 258.—ED.

¹ See Monthly Weather Review for January and October, 1905, Vol. XXXIII, pp. 15 and 444.